DEPARTMENT OF CHEMISTRY

PROFESSORS

AKKAYA, Mahinur: B.S., METU; M.S., Ph.D., Ohio State University.
DOĞAN, Özdemir: (Associate Dean of the Faculty of Arts and Sciences) B.S., M.S., METU; Ph.D., Case Western Reserve University.
GÖKAĞAÇ, Gülsün: ***(Vice Chairperson)***: B.S., M.S., METU; Ph.D., The University of Sydney.
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HACALOĞLU, Jale: B.S., M.S., Ph.D., METU.
KAYRAN, Ceyhan ***(Associate Dean of the Faculty of Arts and Sciences)***: B.S., M.S., Ph.D., METU.
ÖNAL, Ahmet M.: B.S., M.S., Ph.D., METU.
ÖZKAR, Saim: B.S., M.S., ITU; Ph.D..Dipl.Chem., Dr.rer.nat., Technische Universitaet von München.
TANYELİ, Cihangir ***(Chairperson)***: : B.S., M.S., Ph.D., METU.
TİNÇER, Teoman: B.S., M.S., Ph.D., METU.
TOPPARE, Levent: B.S., M.S., Ph.D., METU.
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TÜRKER, Lemi: B.S., M.S., METU; Ph.D., University of East Anglia.
VOLKAN, Mürvet: B.S., M.S., Ph.D., METU.
ZORA, Metin: B.S., Atatürk University; M.S., METU; Ph.D., University of Maryland.
YILMAZ, Ayşen: B.S., M.S., Ph. D., METU.

ASSOCIATE PROFESSORS

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DANIŞMAN, Mehmet Fatih: B.S., M.S., METU; Ph.D., Princeton University
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GÖKTEPE, EREL İrem ; B.S,ITU,Ph.D.Stevens Instıtute of Technology

ASSISTANT PROFESSORS

ÖZÇUBUKÇU, Salih:B.S.,M.S.,METU;Ph.D.,RWTH Aachen University
GÜNBAŞ, E.GÖRKEM: B.S.,M.S.,METU;Ph.D.University of California
ALPTEKİN ASİL,Demet:B.S.M.S:METU:Ph.D.Üniversity of Cambridge
ÇETİNKOL PERSİL,Özgül:B.S:Koç University; Ph.d; The Georgia Instute of Technology

GENERAL INFORMATION: The main objective of the Chemistry Department is to educate students as chemists capable of conducting research and development studies in chemical and related industries as well as analytical work required for quality control in various related laboratories. The department aims particularly at equipping students with knowledge and practical skills for the fundamental research essential for technological progress in our modern world. B.S. candidates in chemistry must follow a four year program as prescribed below. The students are required to complete a summer practice in industry after their third year. Our B.S. graduates can also enroll to the interdisciplinary graduate programs in Polymer Science and Technology (PST), Biochemistry, Biotechnology and Archeometry.

Our graduates have career opportunities in the following areas: Several of our graduates have academic positions at several universities in Turkey and abroad. They have career opportunities in Research and Development Laboratories of Chemical, Petrochemical, Medicinal, Paint, Mining, Metallurgical, Electronic, Plastic, Textile, Ceramic, Glass Pulp, Food and Paper etc. industries. Our graduates also work at Biomedical and Medical Laboratories, Sales and Technical Service Departments of Scientific Instruments and Chemical Companies.

Chemistry Department has the following undergraduate laboratories: General Chemistry Laboratories, Analytical Chemistry Laboratory, Physical Chemistry Laboratory, Organic Chemistry Laboratory, Inorganic Chemistry Laboratory, Organic and Inorganic Industrial Chemistry Laboratory, Instrumental Analysis Laboratory, Polymer Science and Technology laboratory. In addition, there numerous research laboratories of the chemistry faculty.

RESEARCH INTERESTS AND FACILITIES: The major research interests of the faculty is summarized below.

Characterization and synthesis of natural products, highly strained organic compounds, organic reaction mechanism, singlet oxygen chemistry, high temperature bromination of organic compounds. Synthesis and reactions of alycyclic compounds. Catalytic asymmetric synthesis of organic compounds and design of chiral ligands. Electronic absorption spectra, electrochemistry, kinetics and mechanisms of ligand substitution reactions of transition metal complexes. Photo catalytic reactions of olefins. Intrazeolite organometallic chemistry. Preparation and characterization of organometallic compounds. Carbon supported and unsupported Pt and "Pt + second metal" nanoparticle catalysts for direct methanol fuel cells. Electrochemical properties of minerals and mineral enrichment. Solid state reactions of rare earths. Preparation and crystallographic investigation of inorganic materials. Physicochemical studies of colloids and soils. Negative ion studies in the gas phase. Application of quantum chemical methods to spectroscopic studies. Measurement and control of hazardous substances in various environments. Application and development of nuclear, analytical, atomic spectroscopic and chromatographic techniques for pollution studies and for analysis of trace elements in biological materials. Development of various atomic spectrometric techniques. Synthesis and characterization of polymeric materials for industrial use. Application of electrochemical, thermal, radiochemical and r.f. plasma methods for preparation and/or modification of polymeric materials. Developing new methods for preparing ionic, stereoregular and flame-retardant polymers. Conducting polymers. Studies on composites and polymer blends. Simulation studies of polymers and surface dynamics. Synthesis and characterization of polymers for medical and biotechnological applications. Enzyme immobilization, controlled release, biocompatibility studies. Artificial enzymes and fluorescent chemosensors, molecular marker isolation for mapping and genotyping of plants, enzyme kinetics.

Research laboratories are equipped with the following instruments: MS/MS/MS Triple Quadrupole Mass Spectrometer Electrospinning System, 400 MHz solid-liquid Bruker NMR, GC-MS, Huber X-ray diffractometer, Rigaku Miniflex X-Ray Diffractometer, Small Angle X-Ray Scattering, Magnetic Susceptibility meter, Numerous FTIR, UV-Visible, AA, ICP, ICP-OES, and ICP-MS, Fluorescence spectrometers, GC and HPLC, Nuclear Analytical instruments with Ge-Li detector, Lloyd Mechanical Tester, Thermal Analysis (DSC, TGA), Mechanical Dynamic Analyzer, Contact Angle Goniometer, Instron Mechanical Tester, various mechanical property testing devices, Branbender Extruder, hot presses, RF Cold Plasma system, ESR, GPC, automated viscometer, and potensiostats cyclic voltametry and related electrochemical studies. The department also has machine and glass-blowing shops.

UNDERGRADUATE CURRICULUM

FIRST YEAR

First Semester				Second Semester			
CHEM	105	General Chemistry I	(4-4)6	CHEM	106	General Chemistry II	(4-4)6
PHYS	111	Physics I (Mechanics)	(4-2)5	PHYS	112	Physics II (Electricity and Magnetism)	(4-2)5
MATH	119	Calculus with Analytic Geometry	(4-2)5	MATH	120	Calculus for Functions of Several Variables	(4-2)5
ENG	101	English for Academic Purposes I	(4-0)4	ENG	102	English for Academic Purposes II	(4-0)4
				IS	100	Introduction to Information Technologies and Applications	NC

SECOND YEAR

Third Semester

CHEM	221	Analytical Chemistry l I	(4-0)4
CHEM	223	Analytical Chem. Lab.I	(0-6)3
CHEM	233	Introduction to Organic Chemistry	(2-0)2
CHEM	257	Mathematics for Chemists	(4-0)4
Non-technical elective			(3-0)3
HIST	2201	Principles of Kemal Atatürk I	NC
CHEM	200	Colloquium in Chemistry I	(0-2)NC

Fourth Semester

CHEM	234	Organic Chemistry I	(4-0)4
CHEM	236	Organic Chemistry Lab.I	(0-4)2
CHEM	252	Physical Chemistry I	(4-0)4
CHEM	254	Physical Chemistry Lab.I	(0-4)2
ENG	211	Academic Oral Presentation Skills	(3-0)3
Non-technical Elective			(3-0)3
HIST	2202	Principles of Kemal Atatürk II	NC

THIRD YEAR

Fifth Semester

CHEM	301	Organic Chemistry II	(4-0)4
CHEM	303	Organic Chemistry Lab.II	(0-6)3
CHEM	353	Physical Chemistry II	(4-0)4
CHEM	355	Physical Chemistry Lab. II	(0-4)2
CHEM	361	Inorganic Chemistry I	(4-0)4
TURK	303	Turkish I	NC

Sixth Semester

CHEM	322	Analytical Chemistry II	(4-0)4
CHEM	324	Analytical Chem. Lab.II	(0-6)3
CHEM	350	Quantum Chemistry	(3-0)3
CHEM	362	Inorganic Chemistry II	(4-0)4
CHEM	364	Inorganic Chemistry Lab.	(0-4)2
ENG	311	Advanced Communication Skills	(3-0)3
TURK	304	Turkish II	NC

FOURTH YEAR

Seventh Semester

CHEM	413	Biochemistry	(0-3)3
Restricted Elective			(3-0)3
Restricted Elective			(3-0)3
Technical Elective			(3-0)3
CHEM	401	Summer Practice	(0-2)NC
CHEM	400	Colloquium in Chemistry II	(0-2)NC

Eighth Semester

Restricted Elective	(3-0)3
Restricted Elective	(3-0)3
Technical Elective	(3-0)3

Restricted Elective Courses:

1.	CHEM	403	Industrial Chemistry I	(3-0)3
2.	CHEM	408	Analytical Chemistry III	(3-0)3
3.	CHEM	441	Reaction Mechanism in Organic Chemistry	(3-0)3
4.	CHEM	455	Polymer Chemistry I	(3-0)3
5.	CHEM	471	Spectroscopic Methods in Organic Chemistry	(3-0)3
6.	CHEM	481	Advanced Inorganic Chemistry	(3-0)3
7.	CHEM	499	Undergraduate Research	(1-4)3

DOUBLE MAJOR PROGRAM IN CHEMISTRY

The program consists of all courses in the undergraduate program where the applicant must fulfill the Double Major requirements of the University. For the Chemistry Education students a special protocol exists among the two Departments concerned with a lower CGPA limit.

MINOR PROGRAM IN CHEMISTRY

The Chemistry Minor Program aims at providing an opportunity to the successful B.S. students from other departments to attain a basic knowledge and foundation in chemistry. Through this program it will be possible for the students to apply to a wider job market which will not be limited by their major program, and also, they will be in a position to apply to graduate programs in chemistry and chemistry related departments.

To satisfy the minor requirement the six of the following courses must be taken:CHEM 221, CHEM 223, CHEM 252, CHEM 254, CHEM 234, CHEM 236, CHEM 301, CHEM 303, CHEM 322, CHEM 324, CHEM 353, CHEM 355, CHEM 361, CHEM 362, CHEM 364, "Chemistry Elective "

DESCRIPTION OF UNDERGRADUATE COURSES

CHEM 101 GENERAL CHEMISTRY I (4-2)5
(For BIO, BIOED, PHYS and PHED students) A basic course emphasizing the metric system, introduction to stoichiometry, the structural and physical properties of matter, i.e., electronic structure of atoms, chemical binding, molecular geometry, hybridization and molecular orbitals and the states of matter, i.e., gases, liquids and solids.

CHEM 102 GENERAL CHEMISTRY II (4-2)5
(For BED, PHYS and PHED students) Continuation of 2340101. Discussion of physical properties of solutions, chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.
Prerequisite: CHEM 101 or CHEM 105 or
CHEM 109 or CHEM 111.

CHEM 105 GENERAL CHEMISTRY I (4-4)6
(For CHEM and CHED students.) A basic course primarily intended for majors in chemistry includes experiments related to basic chemical principles. Properties of matter, periodic table, chemical bond and states of matter. Laboratory work includes some basic chemical reactions.

CHEM 106 GENERAL CHEMISTRY II (4-4)6
(For CHEM and CHED students.) This course is the continuation of 234105 and includes experiments related to the topics of the course: Chemical thermodynamics, Kinetics, Equilibrium, i.e., acid-base Equilibria, Solubility, Electrochemistry, Nuclear, Organic and Biochemistry.
Prerequisite: CHEM 101 or CHEM 105 or
CHEM 109 or CHEM 111.

CHEM 107 GENERAL CHEMISTRY (3-2)4
(One term course for students of EE, CE, IE, FDE, ENVE, CENG, AEE, ME.) Introduction to atomic and electronic structure, chemical bonding, molecular structure and bonding theories, properties of liquids, solids

and solutions, chemical equilibrium, kinetics, thermodynamics, metal complexes, organic compounds and nuclear chemistry.

CHEM 111 GENERAL CHEMISTRY I (3-2)4
(For GEOE, METE, MINE, PETE and CHE students) A basic course emphasizing the metric system, introduction to stoichiometry, the structural and physical properties of matter, i.e., electronic structure of atoms, chemical binding, molecular geometry, hybridization and molecular orbital and the states of matter, i.e., gases, liquids and solids.

CHEM 112 GENERAL CHEMISTRY II (3-2)4
(For GEOE, METE, MINE, PETE and CHE students) Discussion of physical properties of solutions, chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry.
Prerequisite: CHEM 101 or CHEM 105 or
CHEM 111.

CHEM 200 COLLOQUIUM IN CHEMISTRY I (0-2)NC
A course to inform students about the nature of chemistry and chemistry education and to orientate students. The course is to be conducted in the form of seminars and conferences by the faculty and respected chemists from industry. Should be taken only one semester during the first two years.

CHEM 220 ORGANIC CHEMISTRY (3-2)4
(For CHE students) Introduction to Organic Chemistry. A new mechanistic approach to the study of chemical reactions and survey of hydrocarbons, alcohols, esters, aldehydes, ketones, carboxylic acids (and their derivatives), amines. The course emphasizes the fundamental properties of organic compounds.
Prerequisite : CHEM 102 or CHEM 106 or CHEM 107 or CHEM 110 or CHEM 112.

CHEM 221 ANALYTICAL CHEMISTRY I (4-0)4
(For CHEM and CHED students) Fundamental principles and theories of analytical chemistry. Quantitative analysis by gravimetry. Aqueous solution chemistry. Theory of titrimetric methods of analysis, quantitative analysis by volumetry, data evaluation and statistical treatment.
Prerequisite: CHEM 102 or CHEM 106 or CHEM 107 or CHEM 112.

CHEM 222 ANALYTICAL CHEMISTRY II (3-0)3
(For CHEM and CHED students) A course making students familiar with several instruments and instrumental techniques that are currently used in industry and in research laboratories. Electroanalytical, spectroscopic and chromatographic techniques.

CHEM 223 ANALYTICAL CHEMISTRY LABORATORY I (0-6)3
(For CHEM and CHED students) Gravimetric and volumetric methods of analysis, applications. Related projects. *Prerequisite or corequisite: CHEM 221*

CHEM 224 ANALYTICAL CHEMISTRY LABORATORY II (0-6)3
(For CHEM and CHED students) Instrumental methods for chemical analysis. Experiments for principles and applications of atomic and molecular spectrometry, electroanalytical methods and chromatography.

CHEM 229 ORGANIC CHEMISTRY FOR ENGINEERS (3-2)4
An Introduction to Organic Chemistry A new mechanistic approach to the study of chemical reactions and survey of Hydrocarbons, Alcohols, Esters, Aldehydes and Ketones, Carboxylic Acids and their derivatives, Amines, Aminoacids and Proteins. The course emphasizes fundamental properties of organic compounds.
Prerequisite: CHEM 102 or CHEM 106 or
CHEM 107 or CHEM 112

CHEM 230 ANALYTICAL CHEMISTRY FOR ENGINEERS (3-2)4
Fundamentals and theories of analytical chemistry. Data evaluation, errors. Theory and applications of volumetry and electroanalytical chemistry.
Prerequisite: CHEM 102 or CHEM 106 or
CHEM 107 or CHEM 112

CHEM 231 ORGANIC CHEMISTRY (3-4)5
Introduction to Organic Chemistry. A new mechanistic approach to the study of chemical reactions and survey of hydrocarbons, alcohols, esters, aldehydes and ketones, carboxylic acids and their derivatives, amines, amino acids and proteins.
Prerequisite: CHEM 102 or CHEM 106 or
CHEM 107 or CHEM 110 or CHEM 112

CHEM 233 INTRODUCTION TO ORGANIC CHEMISTY (2-0)2
(For Chem Students) An introduction to Organic Chemistry. A short summary of chemical bonds, Lewis structures, formal charge, resonance, atomic and molecular orbitals, hybridization of organic molecules and geometries. Representative carbon compounds: functional groups. Fundamental principles of Organic reactions. Nomenclature and conformational analysis of Alkanes. The course emphasizes Stereochemistry and ionic reactions i.e. nucleophilic substitution and elimination reactions. *Prerequisite: CHEM 106*

CHEM 234 ORGANIC CHEMISTY I (4-0)4
((For Chem Students) Introduction to Organic Chemistry. A new mechanistic approach to the study of chemical reactions and a survey of Alkanes, Alkenes, Alkynes, Alcohol and Ethers. The course emphasizes Stereochemistry and fundamental properties of organic compounds.
Prerequisite: CHEM 220 or CHEM 229 or
CHEM 231 or CHEM 233

CHEM 236 ORGANIC CHEMISTRY LAB. I (0-4)2
Applications of general organic chemistry laboratory techniques.
Prerequisite: CHEM 233
Prerequisite or co requisite: CHEM 234.

CHEM 252 PHYSICAL CHEMISTRY I (4-0)4
This course is designed to provide the basic knowledge on thermodynamics and the first and the second laws of thermodynamics. The first part of this course covers material equilibrium, standard thermodynamics of reaction and reaction equilibrium. In the final part of the course, real gases, kinetic theory of gases and phase equilibria are discussed.
Prerequisites: PHYS 111 or PHYS 105 and
CHEM 106 or CHEM 107 and CHEM 257 or MATH 219

CHEM 254 PHYSICAL CHEMISTRY LABORATORY I (0-4)2
Experimental techniques related to the content of physical chemistry courses (Gases, Liquids, Colligative Properties, Phase Equilibria, Thermochemistry).
Prerequisites: CHEM 102 or CHEM 106 or CHEM 112, and CHEM 257.
Prerequisite or co requisite: CHEM 252.

CHEM 257 MATHEMATICS FOR CHEMISTS (4-0)4
Functions of single and multivariables, partial differential, Laxgrange multipliers. Newton-Raphson method. Numerical integration. First order differential equations of types exact, linear, homogenous, separable. Higher order differential equations with constant coefficients. Matrixes, and determinants. Set of linear equations. Emphasis on chemical problems.
Prerequisite: MATH 120 or MATH 152 or
MATH 156.

CHEM 281 FUND.OF ANAL.AND INORG.CHEMISTRY (3-0)3
This course is designed to give some basic concepts of analytical and inorganic chemistry. Chemical analysis, evaluation of data, gravimetry, volumetry, neutralization, precipitation, oxidation and reduction titrations, coordination chemistry, structure of solids, chemistry of metals and non-metals.
Prerequisite: CHEM 102 or CHEM 106 or
CHEM 107 or CHEM 112.

CHEM 282 FUND.OF ORGANIC CHEMISTRY (3-0)3
An introduction to organic chemistry. A new mechanistic approach to the study of chemical reactions and survey of hydrocarbons, alcohols, esters, aldehydes, ketones carboxylic acids and their derivatives; aromatic

compounds, amines, aminoacids and proteins. The course also emphasizes fundamentals of biochemistry; enzymes, metabolic transformations, membrane structure and functions.
Prerequisite: CHEM 102 or CHEM 106 or CHEM 107 or CHEM 112.

CHEM 283 GENERAL CHEMISTRY (3-2)4
(One term course for students of ELE) A short summary of structure of matter, stoichiometry, chemical reaction in solution, energy and thermochemistry. Discussion of atomic structure, chemical bonding, properties of gases, liquids and solids. Basic concepts of thermodynamics, kinetics, chemical equilibrium, acid-base equilibrium, solubility and simultaneous equilibria, electrochemistry and organic chemistry.

CHEM 301 ORGANIC CHEMISTRY II (4-0)4
Detailed study of Aromatic Compounds, Aldehydes, Ketones, Carboxylic acids (and their derivatives), and amines. The course also introduces students to spectroscopic identification of organic compounds. Mechanistic approach is used throughout the course.
Prerequisite: CHEM 234 or CHEM 220 and consent of the department.

CHEM 303 ORGANIC CHEMISTRY LAB. II (0-6)3
Synthetic applications of organic laboratory techniques.
Prerequisite: CHEM 236.
Prerequisite or co requisite: CHEM 301.

CHEM 322 ANALYTICAL CHEMISTRY II (4-0)4
(For CHEM and CHED students) A course making students familiar with several instruments and instrumental techniques that are currently used in industry and in research laboratories. Electroanalytical, spectroscopic and chromatographic techniques. *Prerequisite: CHEM 221*

CHEM 324 ANALYTICAL CHEMISTRY LABORATORY LI (0-6)3
(For CHEM and CHED students) Instrumental methods for chemical analysis. Experiments for principles and applications of atomic and molecular spectrometry, electroanalytical methods and chromatography.
Prerequisite: CHEM 223
Prerequisite or co requisite: CHEM 322.

CHEM 331 ORGANIC CHEMISTRY I (4-0)4
Introduction to Organic Chemistry. A new mechanistic approach to the study of chemical reactions and a survey of Alkanes, Alkenes, Alkynes, Alcohol and Ethers. The course emphasizes Stereochemistry and fundamental properties of organic compounds.

CHEM 332 ORGANIC CHEMISTRY II (4-0)4
Detailed study of Aromatic Compounds, Aldehydes, Ketones, Carboxylic acids (and their derivatives), and amines. The course also introduces students to spectroscopic identification of organic compounds. Mechanistic approach is used throughout the course.

CHEM 333 ORGANIC CHEMISTRY LAB .I (0-4)2
Applications of general organic chemistry laboratory techniques.

CHEM 334 ORGANIC CHEMISTRY LAB .II (0-6)3
Synthetic applications of organic laboratory techniques.

CHEM 343 INTRODUCTION TO POLYMER SCIENCE (3-0)3
Brief history of macromolecular science, some basic concepts of polymer science, polymers in nature, synthetic polymers, resins, blends and plastics, polymer composites, ceramics. Homo and block copolymers, branched and network polymers. *Prerequisite: Consent of the department.*

CHEM 350 QUANTUM CHEMISTRY (3-0)3
Particles and waves, principles of quantum mechanics, stationary states. Electronic structure of atoms and molecules. The chemical bond. Approximate methods. Vibrational, rotational and electronic transitions. Spectroscopy.
Prerequisites: PHYS 112 and CHEM 252, or PHYS 106 and CHEM 252 and consent of the department.

CHEM 353 PHYSICAL CHEMISTRY II (4-0)4
This course covers an extensive application of physicochemical topics such as kinetics of elementary and complex reactions, molecular reaction dynamics, electrochemical systems and problems related to the topics.
Prerequisite: CHEM 252

CHEM 355 PHYSICAL CHEMISTRY LABORATORY II (0-4)2
Experimental techniques related to the content of physical chemistry courses (Gases, liquids, chemical kinetics, thermochemistry, Electrochemistry).
Prerequisite: CHEM 254
Prerequisite or co requisite: CHEM 353.

CHEM 361 INORGANIC CHEMISRTY I (4-0)4
Atomic structure, periodic table, inorganic nomenclature, chemical bonds, molecular structure and symmetry, covalent bond, molecular orbital theory, solid state, acids and bases. The course includes some demo experiments, model building and video shows. *Prerequisite: CHEM 252*

CHEM 362 INORGANIC CHEMISTRY II (4-0)4
Coordination compounds, oxidation and reduction, systematic chemistry of the metals, hydrogen and its compounds, main group organometallic compounds, systematic chemistry of the nonmetals.
Prerequisite: CHEM 361

CHEM 364 INORGANIC CHEMISTRY LABORATORY (0-4)2
Safety and basic techniques in inorganic chemistry laboratory, synthesis and characterization of some inorganic compounds. Structure and reactivity of some inorganic compounds.
Prerequisites: CHEM 361
Prerequisite or co requisite: CHEM 362

CHEM 400 COLLOQUIUM IN CHEMISTRY II (0-2)NC
A course to guide students about professional opportunities, issues and responsibilities; to inform about the recent advances in the field. Areas in chemistry research. The course is to be conducted in the form of seminars and conferences by the faculty and respected chemists from industry. Should be taken for only one semester during the last two years.
Prerequisite: CHEM 200.

CHEM 401 SUMMER PRACTICE (0-2)NC
Six weeks of summer practice in industry after third year, under the quidance of the department.

CHEM 403 INDUSTRIAL CHEMISTRY I (4-0)4
Definitions of chemical plant production, economics of chemical productions, separation methods. Discussion of the properties and the production methods of basic chemicals.
Prerequisite: CHEM 221 and CHEM 234, or Consent of the department.

CHEM 404 INDUSTRIAL CHEMISTRY II (3-0)3
Discussion of basic organic chemicals, their properties industrial productions and their inter-relations with emphasis on the economic aspects of chemical production.
Prerequisites: CHEM 221 and CHEM 234, or Consent of the department

CHEM 405 ADVANCED LABORATORY PRACTICE (0-6)3
Synthesis of Inorganic and Organic compounds and quantitative and qualitative characterization of the products by instrumental analysis.

CHEM 406 INDUSTRIAL CHEMISTRY LABORATORY (0-4)2
Experiments based on major industrial processes, operations and methods of analysis of industrial chemicals and materials. *Prerequisites: CHEM 221 and CHEM 234 or Consent of the department*

CHEM 407 ORGANIC CHEMISTRY III (3-0)3
Detailed information on the chemistry of carbohydrates, lipids, amino acids, proteins and nucleic acids.
Prerequisite: CHEM 301 or Consent of the department

CHEM 408 ANALYTICAL CHEMISTRY III (3-0)3
Topics in instrumental methods of analysis. IR and Raman spectrometry, atomic and molecular mass spectrometry, surface characterization techniques, atomic X-ray spectrometry and radiochemical analysis techniques.
Prerequisite: CHEM 322 or Consent of the department.

CHEM 412 SPECIAL TOPICS IN CHEMISTRY: PATENTS IN CHEMICAL INNOVATIONS (3-0)3
The courses are designed to deepen the students' knowledge in selected area of Chemistry. Contents may vary from year according to the interest of students and instructor in charge.

CHEM 413 BIOCHEMISTRY (3-0)3
A chemical approach to biochemistry. A study of the structures and functions of biomolecules, metabolism and bioenergetics, replication, transcription and translation processes with an emphasis on the chemical structures, transformations. *Prerequisite: CHEM 234*

CHEM 414 CHEMISTRY OF METABOLIC PATHWAYS (3-0)3
The course is designed as an extension to the Biochemistry course in the core curriculum of the Chemistry Program by focusing on chemical reactions
involed in the fundamentals of metabolism and bioenergetics

CHEM 416 ARTIFICIAL ENZYMES (3-0)3
A study of synthetic molecules that mimic the actions of, or interact with the biomolecules. Using pertinent literature examples, design and synthesis of enzyme models, artificial enzymes, de novo designed proteins and molecular receptors will be discussed. *Prerequisite: CHEM 301 or Consent of the department.*

CHEM 424 ANALYTICAL SEPARATION METHODS (3-0)3
A brief review of physical separation principles, solvent extraction, distillation. Theory and applications of GLC, HPLC and Ion Chromatography. Contemporary developments in chromatographic techniques.
Prerequisites: CHEM 322 or Consent of the department

CHEM 425 ATOMIC AND MOLECULAR SPECTROMETRY (3-0)3
Instrumental systems and principles for chemical analysis of atoms and molecules using spectrometric techniques. Detailed studies in instrumental design, analytical parameters and applications.
Prerequisites: CHEM 322 or Consent of the department

CHEM 426 CHEMOMETRICS FOR ANALYTICAL CHEMISTRY (3-0)3
Basic statistics for analytical chemistry. Principles of experimental design, factorial and fractional factorial designs. Response surface methodology. *Prerequisite: CHEM 324 or Consent of the department*

CHEM 428 INTRODUCTION TO BIOANALYTICAL SENSORS (3-0)3
A systematic and comprehensive introduction to the principle feactures of bionalytical sensors, their consruction and applications in a range of fields are discussed.

CHEM 429 SIMULATION TECHNIQUES IN THEORETICAL CHEMISTRY (2-2)3
Introduction to scientific computing. Simulation techniques in Theoretical Chemistry and Biology, such as Molecular Dynamics, Molecular Quantum Chemistry, protein folding and neural networks. Hands-on development of simple computational codes.
Prerequisite: CHEM 257 or Consent of the instructor.

CHEM 431 INTRODUCTION TO CRYSTALLOGRAPHY (3-0)3
Lattice Structure, Symmetry of Crystals, Crystal Lattices and Space Groups, Properties of X-rays, Diffraction, Structure Determination by Powder Methods, Structure Determination by Single Crystal Methods.
Prerequisite: CHEM, or Consent of the department.

CHEM 432 SOLID STATE CHEMISTRY&INORGANICMATERIA (3-0)3
Solids, Bonding in Solids and Electronic Properties, Lattice Defects and Non-stoichiometry, Low Dimensional Solids, Zeolites, Optical Properties of Solids Magnetic Properties of Solids, Supercondictivity, Inorganic materials. *Prerequisite: CHEM 361 or Consent of the department.*

CHEM 433 CHEMISTRY OF TRANSITION METALS (3-0)3
Electronic spectra of complexes, Reaction Mechanism of d-Block Complexes, d-and-f- Block Organometallic Compounds, Catalysis.

CHEM 434 SELECTED TOPICS IN ANALYTICAL CHEMISTRY (3-0)3
A survey of selected topics dealing with experimental techniques and set-ups used in analytical chemistry.
Prerequisite: Consent of the the department.

CHEM 435 BIOORGANIC CHEMISTRY (3-0)3
The important reactions in biological systems. The stereospecifity and the mechanism of reactions.
Prerequisite: CHEM 301 or Consent of the department.

CHEM 437 INORGANIC STRUCTURAL CHEMISTRY (3-0)3
The course deals with the elucidation and description of the spatial order of atoms in a compound, describes the structural principles of inorganic molecules and solids using traditional concepts as well as modern approaches. Relations of structures and properties are also discussed.
Prerequisite: CHEM 361 or Consent of the department.

CHEM 438 PHYSICAL METHODS IN INORGANIC CHEMISTRY (3-0)3
General introduction to Spectroscopy, Electron absorption spectroscopy, Infrared Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Electron Paramagnetic Resonance Spectroscopy, Mössbauer Spectroscopy, X-Ray Diffractions.
Prerequisite: CHEM 361 or Consent of the department.

CHEM 439 MOLECULAR SPECTROSCOPY&PHOTOCHEMISTRY (3-0)3
A short summary of quantum mechanics, molecular symmetry and group theory, rotational, vibrational and electronic spectroscopies, photoelectron and related spectroscopies, photochemistry, lasers and laser spectroscopy. *Prerequisite: CHEM 252 or Consent of the department.*

CHEM 440 CHEMISTRY OF NUTRITION I (3-0)3
This course is designed to give insights into chemistry of carbohydrates, lipids and proteins, fat and water soluble vitamins and minerals in human nutrition. Deficiencies, requirements, sources, toxicities (if any) of these nutrients together with their interactions will be covered.

CHEM 441 REACTION MECHANISMS IN ORGANIC CHEMISTRY (3-0)3
Course is designed to show how basic principles of organic chemistry work out in explaining the variation of reactivity with structure , the occurrence of electrophiles, nucleophiles and radicals and their behaviour in the fundamental reactions of organic chemistry such as substitution, addition, elimination and rearrangement.
Prerequisites: CHEM 301

CHEM 442 INDUSTRIAL CHEMICAL CALCULATIONS (3-0)3
Units, dimensions and their conversions, review of selected topics to stoichiometric calculations, material balances, energy balances, combined material and energy balances.
Prerequisite: Consent of the department.

CHEM 444 THE CHEMISTRY OF DYES AND PIGMENTS (3-0)3
Detailed information on the dyes and pigments of organic and inorganic nature. *Prerequisite: CHEM 301.*

CHEM 447 SURFACE CHEMISTRY (3-0)3
Thermodynamics of interfaces, Laplace and Kelvin Equations, surface films on liquids, adsorption of gases on solids. Electrical double layer, double layer interaction and particle coagulation, stabilization and coagulation of suspensions. Emulsion stability and microemulsions.
Prerequisite: CHEM 221 and CHEM 234 or
Consent of the department

CHEM 448 HETEROCYCLIC CHEMISTRY (3-0)3
The relationship between structure and chemical and physical properties of pi-deficient and pi-excessive heterocyclic compounds. The synthesis of heterocyclic compounds are briefly discussed.
Prerequisite: CHEM 221 and CHEM 234 or Consent of the department

CHEM 450 ELECTROCHEMISTRY II (3-0)3
Electro-reduction and oxidation mechanisms of various compounds, principles and applications of polarography, cyclic voltammetry, chrono voltammetry and similar techniques along with metal coating and corrosion are among the subjects covered in this course. Applications of these techniques in polymer chemistry and synthesis and characterization of conducting polymers.
Prerequisite: Consent of the department.

CHEM 452 NUCLEAR ANALYTICAL TECHNIQUES (3-0)3
Introduction to Nuclear sciences. Radioactive decay. Interaction of radiation with matter. Radiation detection and measurement. Radio analytical techniques and applications. Nuclear analysis techniques in medicine, geology and archeology.
Prerequisite: Consent of the department

CHEM 453 ENVIRONMENTAL CHEMISTRY (3-0)3
Chemical problems related to environment. Energy balance of the earth, ozone in the stratosphere, micro meteorology, acid deposition, greenhouse effect, photochemical smog and particles in the environment.
Prerequisite: CHEM 221 or Consent of the department

CHEM 455 POLYMER CHEMISTRY I (3-0)3
A comprehensive course in high polymer chemistry. Polymer chains and characterization methods. Statistics and kinetics of polymerization reaction. Structure and property relations of bulk polymers. Properties of commercial polymers. *Prerequisite: CHEM 353 or Consent of the department.*

CHEM 456 POLYMER CHEMISTRY II (3-0)3
Introductory information about polymer characterization in solution and in bulk. Polymer conformation and configuration, polymer solutions, molecular weight determinations, thermal, mechanical, physical properties, polymer crystallization, morphology in solid state, polymer structure - property relations.
Prerequisite: CHEM 252 or Consent of the department

CHEM 457 ORGANIC CHEM. SOME BIOL.ACTIVE COMPOU. (3-0)3
The course is designed to enable students to adopt a more critical outlook towards organic synthesis. Certain fundamental chemical reactions leading to molecules with biological or synthetic significance are reviewed. Some of the classes of compounds studied: steroids, alkaloids, postglandines, B-lactams, tetracyclines. Certain aspects of the pharmaceutical industry including that of Turkey is surveyed.
Prerequisite: CHEM 301 or Consent of the department

CHEM 464 SUSTAINABLE LIVING AND GREEN CHEMISTRY (3-0)3
Sustainability with its four dimensions; ecological, economic, social and cultural/worldview. Green Chemistry, resources waste, soil, food, energy, problems, alternatives and solutions.

CHEM 465 POLIMER TECHNOLOGY&RELATED INDUSTRIES (3-0)3
Structure-Property relations of commercially important polymers. Manufacturing and processing of natural synthetic fibers, rubbers and plastics. The basic industrial organic chemistry of monomer and polymer synthesis. The industrial chemistry of paints, varnishes and lacquers.

CHEM 466 CHEM. & SPECT.TECH.FOR BIOL. MACROMOL. (3-0)3
This course covers theory and applications of selected chemical and spectroscopic techniques which are necessary for the study of biochemical systems. Absorption, circular dichroism, luminescence and polarization, NMR, ultra-centrifugation, viscometry, electrophoresis, x-ray scattering and diffraction techniques.
Prerequisite: Consent of the department.

CHEM 468 POLYMERIC MATERIALS (3-0)3
Introduction to polymer science and classification of polymers. Basic of polymerization reactions and synthesis of polymers. Chemical and physical structure of polymers and their characteristics. Thermal and mechanical properties of polymers. Other physical properties and chemical resistance of polymers. Commodity plastics and rubbers. Engineering polymers and advanced polymer technologies.
Prerequisite: Consent of the department.

CHEM 469 INTRODUCTION TO MEDICINAL CHEMISTRY (3-0)3
This course focuses on how theory and technique are used as tools to understand the behaviours and properties of biological macromolecules. Thermodynamics and kinetics of conformational changes and ligand interactions.
Prerequisite: CHEM 220 or CHEM 229 or
CHEM 231 or CHEM 234.

CHEM 471 SPECTROSCOPIC METHODS IN ORGANIC CHEM. (3-0)3
Analysis of organic molecular structures by the use of modern spectroscopic and spectrometric methods of UV, IR, mass, and NMR.
Prerequisite: CHEM 234 or Consent of the department.

CHEM 472 SPECTROSCOPIC METHODS IN CHEMISTRY (3-0)3
Structure elucidation of compounds by the use of modern spectroscopic and spectrometric methods. *Prerequisites: CHEM 221 and CHEM 234 or Consent of the department.*

CHEM 476 POLYMER MATERIALS SCIENCE (3-0)3
In this course, properties of polymer materials are discussed with a certain depth by stressing on the structure and property relationships. The viscoelastic properties of polymers are reviewed by use of available theories and their significance in polymer properties are discussed.
Prerequisite: CHEM 455.

CHEM 478 POLYMER COMPOSITES (3-0)3
In this course, a very important class of materials known as composites are discussed. Polymer composites containing certain fillers, polymer blends and polymer foams are covered in the course emphasizing on the related equations connecting filler characteristics with various mechanical, physical and other properties.
Prerequisite: Consent of the department.

CHEM 481 ADVANCED INORGARNIC CHEMISTRY (3-0)3
Electronic spectra of complexes, Reaction Mechanism of d-Block Complexes, d-and-f- Block Organometallic Compounds, Catalysis. *Prerequisite: CHEM 362.*

CHEM 483 INTRODUC. TO SURFACE AND COLLOID CHEMISTRY (3-0)3
Basic terms in surface and colloid chemistry, the kinetic properties of disperse systems, interfacial phenomena, the optical and electrical properties of colloids, the preparation and stability of colloids, properties of gels, emulsions, foams and aerosols.
Prerequisite: CHEM 221 and CHEM 252 or
Consent of the department.

CHEM 484 POLYMER SOLUTIONS (3-0)3
In this course, the principles of solubility, solvation and association of polymers and swelling properties of gels are outlined. Basic principles of polymer solution thermodynamics, phase equilibria in polymer solutions and polymer solution viscosities are studied. *Prerequisite: Consent of the department.*

CHEM 485 PHYSICS AND CHEMISTRY OF SURFACES AND ORGANIC THIN FILMS (2-2)3
Yüzey yapısı: İki boyutlu gerçek ve ters örgüler, Miller indeksleri, yüzey yapıları için notasyon. Yüzey termodinamiği. Yüzey dinamiği: titreşimler, adsorpsiyon, desorption, difüzyon. Yüzey kimsayal bağları ve kataliz. Yüzey analitik teknikleri: saçılma, spektroskopi, mikroskopi. Organik ince filmler: thiol ve silane kendiliğinden düzenlenmiş tek tabakaların ve organik yarı iletken filmlerin hazırlanması, karakterizasyon ve uygulamaları.

CHEM 486 POLYMERIC BUILDING MATERIALS (3-0)3
A brief review of polymers, their synthesis and properties. Detailed information about polymers in Composites, concrete composites, foams, adhesives and sealants, solar energy conservation, roofing and flooring and polymer degradation. *Prerequisite: Consent of the department.*

CHEM 489 COMPUTATIONAL CHEMISTRY (2-2)3
Theoretical methods in computational chemistry, ranging from wave function methods to density functional theory and response theory methods. Hands-on practice with popular quantum chemistry software.
Prerequisite: CHEM 350 or PHYS 300

CHEM 491 DEVELOPMENTS OF CHEMISTRY I (3-0)3
Chemical apparatus techniques and chemicals used for dying and tanning in Mesopotamia since 4000 B.C. are explained. Precious metals such as gold, silver and imitations of precious stones handled by Mesopotamian and Egyptian chemists are examined. The influence of Greek philosophers an experimental chemistry practiced in Mesopotamia and Egypt are discussed. *Prerequisite: Consent of the department.*

CHEM 492 DEVELOPMENTS OF CHEMISTRY II (3-0)3
An introduction to modern Chemistry since alchemy is made. The role of late alchemists and development of organic and inorganic chemistry are discussed. Historical development of electrochemistry, thermodynamics, chemical kinetics, polymer chemistry, chemistry of photographic emulsions, rocket propellants and nuclear chemistry are examined. The history of some basic laws of chemistry is examined.
Prerequisite: Consent of the department.

CHEM 493 USE OF COMPUTERS IN CHEMISTRY II (3-2)4
Programming in PASCAL; transfer of data PASCAL into windows environment. Graphics; applications in various fields of chemistry.

CHEM 495 CHEMISTRY IN POPULAR CULTURE (3-0)3
Review of the chemical facts which are used in popular media. A summary of chemistry in daily life, from medicines to toxic compounds, explosives, anesthetics and daily products etc. Prerequisite: Chem 301 or Consent of the department. *Prerequisite: CHEM 301 or Consent of the department.*

CHEM 499 UNDERGRADUATE RESEARCH (1-4)3
This course is intended to improve the research capabilities of graduating students. Each student will be project and an academic advisor; lectures will be given on research design, data evaluation and report writing. A final report and/or a seminar is required at the end of the semester. *Prerequisite: Consent of the department.*

GRADUATE PROGRAMS AT THE DEPARTMENT OF CHEMISTRY

The University requirements for the M.S. and Ph.D. degrees are described in Academic Rules and Regulations (Graduate Programs) of this Catalog.

AIMS AND OBJECTIVE OF GRADUATE PROGRAM: To educate research chemists capable of applying known methods and techniques and developing new ones for the purpose of solving problems in basic and applied topics of Analytical, Inorganic, Organic, Physical, Polymer chemistry and Biochemistry.

Our M.S. and Ph.D. graduates have career opportunities in academia and research and development laboratories in chemical, pulp and paper etc. industries; biomedical and medical laboratories; sales and technical service departments of scientific instrument and chemical companies.

The Chemistry Department offers research opportunities in almost all fields of Chemistry supported by a large and experienced faculty. The department, as one of the foremost research centers of our country, takes pride in the quality of its graduates.

GRADUATE CURRICULUM

M.S. in Chemistry

CHEM	500	M.S. Thesis	NC
CHEM	501	Seminar in Chemistry I	(0-2)NC
CHEM	502	Seminar in Chemistry II	(0-2)NC

5 elective courses
2 must courses*

*Two of the following courses

CHEM	591	Advanced Topics in Organic Chemistry	(3-0)3
CHEM	592	Advanced Chemical Perspectives in Biochemistry	(3-0)3
CHEM	593	Advanced Topics in Analytical Chemistry	(3-0)3
CHEM	595	Advanced Topics in Inorganic Chemistry	(3-0)3
CHEM	597	Advanced Topics in Physical Chemistry	(3-0)3

Total minimum credit: 21
Number of courses with credit (min): 7

Ph.D. in Chemistry
If admitted by M.S. degree

CHEM	600	Ph.D. Thesis	NC
CHEM	601	Seminar in Chemistry III	(0-2)NC
CHEM	602	Seminar in Chemistry IV	(0-2)NC

5 Elective courses
2 must courses*

*Two of the following courses

CHEM	591	Advanced Topics in Organic Chemistry	(3-0)3
CHEM	592	Advanced Chemical Perspectives in Biochemistry	(3-0)3
CHEM	593	Advanced Topics in Analytical Chemistry	(3-0)3
CHEM	595	Advanced Topics in Inorganic Chemistry	(3-0)3
CHEM	597	Advanced Topics in Physical Chemistry	(3-0)3

Total minimum credit: 21
Number of courses with credit (min): 7

Ph.D. in Chemistry
If admitted by B.S. degree

CHEM	600	Ph.D. Thesis	NC
CHEM	501	Seminar in Chemistry I	(0-2)NC
CHEM	502	Seminar in Chemistry II	(0-2)NC
CHEM	601	Seminar in Chemistry III	(0-2)NC
CHEM	602	Seminar in Chemistry IV	(0-2)NC

10 Elective courses
4 must courses*

*Four of the following courses

CHEM	591	Advanced Topics in Organic Chemistry	(3-0)3
CHEM	592	Advanced Chemical Perspectives in Biochemistry	(3-0)3
CHEM	593	Advanced Topics in Analytical Chemistry	(3-0)3
CHEM	595	Advanced Topics in Inorganic Chemistry	(3-0)3
CHEM	597	Advanced Topics in Physical Chemistry	(3-0)3

Total minimum credit: 42
Number of courses with credit (min): 14

DESCRIPTION OF GRADUATE COURSES

CHEM 500 M.S. THESIS NC
Program of research leading to M.S. degree, arranged between student and a faculty member. Students register to this course in all semesters starting from the beginning of their second semester while the research program or write-up of thesis is in progress.

CHEM 501 SEMINAR IN CHEMISTRY I (0-2)0
This seminar consists of meetings among the department staff, invited guests and graduate students to discuss recent developments in Chemistry.

CHEM 502 SEMINAR IN CHEMISTRY II (0-2)0
A continuation of 2340501.

CHEM 504 CHEMISTRY OF OPTOELECTRONIC SYSTEMS (3-0)3
Organic molecules and polymers, Conjugated Polymers, synthesis, optical and electrical properties, Applications of conjugated systems: solar cells, light emitting diodes, electrochromic devices and transistors. Some of the characterization techniques for morphology (such as AFM, TEM, XRD, etc.)

CHEM 511 RADIATION CHEMISTRY (3-0)3
Interaction of radiation with matter, ions, excited states, radicals, radiation chemistry of water and aqueous solutions. Radiation chemistry of some chemical systems. Applications.

CHEM 512 DEGRADATION&STABILIZATION OF POLYMERS (3-0)3
The concept of polymer degradation is discussed. The types of degradation and the resultant chemical changes in the polymer are reviewed. The stabilization of polymers against these undesirable deteriorating effects and some industrial problems of degradation and stabilization are discussed.

CHEM 515 PHYSICAL ORGANIC CHEMISTRY (3-0)3
Molecular properties. Free energy and entropy. Acids and bases, Hammet equation. Catalysis. Free energy relationships. Isotope effects. Solvent effects. Molecular structure and chemical reactivity.
Prerequisite : Consent of the Department.

CHEM 517 COLLOID&SURFACE CHEMISTRY OF SOIL (3-0)3
Disperse systems, their description and basic mechanical behavior, soil minerals, basic silicate structures and clay minerals, clay suspensions: electrical double layer theories, solid-liquid, solid-gas, solid-solid interfaces. Chemical soil stabilization. Laboratory work consist of related experiments.

CHEM 518 COORDINATION AND CATALYSIS (3-0)3
A review of structures and properties of coordination compounds. The use of organotransition metal complexes to catalyze the conversion of unsaturated substance into alcohols, ketones, carboxylic acids, aldehydes, polymers, etc. Discussions of reaction mechanism of catalytic isomerization, hydrogenation, hydroformylation addition, substitution, metathesis reaction, activation of oxygen and nitrogen, and their importance in industry.

CHEM 519 NANOCHEMISTRY (3-0)3
Chemistry of nanomaterials. Different types of nanomaterials (metal nanoparticles, semiconductor nanoparticles, nanowires, nanorods, nanotubes, quantum dots, fullerenes, clusters). Synthesis and characterization methods, surface modification, functionalization, assembly, special properties (such as optical, electronic, catalytic, magnetic). Application of nanomaterials (fuel cell, catalysis, batteries, sensing and imaging, drug delivery).

CHEM 520 NUCLEAR MAGNETIC RESONANCE (3-0)3
Basic theory of NMR, macroscopic treatment, NMR in laboratory and rotating frames, NMR signal, resolution and sensitivity, NMR instrumentation, NMR parameters, proton NMR, chemical shift, Spin-spin coupling, Analysis of complex spin systems.

CHEM 524 HIGH RESOLUTION NMR (3-0)3
Principles of pulsed NMR, Fourier Transformation spectrum accumulation, double-resonance techniques, data handling, 13C-NMR spectroscopy, Multiple pulse methods, INEPT and DEPT, spectrum editing, two dimensional NMR, dynamic NMR, NMR in solid state.

CHEM 525 MASS SPECTROSCOPY (3-0)3
Basic principles of mass spectroscopy. Ionization and fragmentation processes, their thermochemical aspects. Mass spectrometers: vacuum instruments, ion sources, mass analyzers, detectors. Applications in analytical, organic, physical and polymer chemistry.

CHEM 528 POLYMER MOLECULAR WEIGHTS (3-0)3
Fundamental concepts on the various molecular weights of polymers and their distributions. Fractionation and their procedures, membrane osmometry, end group determination, light scattering from solutions, viscometric methods, ultracentrifuge sedimentation method and various methods for the determination of molecular weights of linear polymers related with their physical properties.

CHEM 529 ORGANIC STEREOCHEMISTRY (3-0)3
Basic concepts of stereochemistry. Resolution of racemic forms, preparation of streoisomers, asymmetric synthesis, chiroptical methods in structure elucidation.

CHEM 531 REACTIVE INTERMEDIATES I (3-0)3
Carbonise: structure and reactivity, generation of carbones, cycloadditionreactions of carbones, insertion and rearrangement, synthetic application. Nitrenes: generation insertions of nitrenes and rearrangement and synthetic application. Singlet oxygen: generation, reaction of singlet oxygen, chemistry of bicyclic endoperoxides. Consent of the department reaction mechanism in organic chemistry is strongly recommended.

CHEM 532 CHEMISTRY OF NUTRITION (3-0)3
The Chemistry, functions, deficiencies, recommended intakes, toxicities, if any, and sources of carbonhydrates, lipids, proteins, water soluble B and C vitamins, a soluble A, D, E, K vitamins, major minerals e, g, Na, K, Ca, P and trace minerals e, g, Zn, Fe, Se, Cr, I, Cu, Mn and others in human nutrition.

CHEM 533 ORGANOMETALLIC CHEMISTRY (3-0)3
A detailed study of structures, properties, characterization, synthesis and reactions of organometallic compounds as well as their applications to organic synthesis and homogeneous catalysis. Discussion of oxidative addition, reductive elimination, insertion, elimination, ligand substitution reactions, nucleophilic and electrophilic addition and abstraction. The main objective of the course is to show how organometallic chemistry has responded to the challenge of synthesizing novel organic chemicals for research and industry.

CHEM 534 REACTIVE INTERMEDIATES II (3-0)3
Strained Compounds: Arynes, cycloalkynes and cycloallenes, Bridgehead double bonds, tetrahedrane, benzene isomers. Radicals: Structure, generation and reactivity, decomposition mechanism of radicals. Carbocations: Generation, reactivity, rearrangement, synthetic application. Carbonions: Structure, reactivity, rearrangement. Consent of the department Reaction Mechanism in Organic Chemistry is Strongly recommended.

CHEM 537 ORGANIC CHEMISTRY OF MACROMOLECULES (3-0)3
Discussion of chemistry of monomer and polymer formations. Stereochemistry of polymer structure and forces of stereoregulation. Step-growth and chain-growth polymerization reactions. Homogenous and heterogenous catalysis of polymerizations. Degradation reactions of polymers.

CHEM 540 GROUP THEORY AND ITS CHEM. APPL. (3-0)3
The course consists of two parts. In the first, principles, definitions and theorems of group theory, molecular symmetry representations of groups, group theory and quantum mechanics; in the second part, applications; symmetry aspects of molecular orbital theory, ligand field theory. VIS and UV spectra of transition metal complexes, metalligand bonding, molecular vibrations, and symmetry rules are considered.

CHEM 542 X-RAY ANALYSIS (3-0)3
Production and properties of X-rays. Geometry of crystals, symmetry operations, point and space groups. Theory of X-ray diffraction, powder and single crystal diffraction patterns. Determination of crystal structures

and unit cell dimensions. Fourier transform Rietveld analysis. Analysis by X-ray diffraction and fluorescence methods.

CHEM 543 PHYSICAL CHEM.OF MACROMOL. IN SOLUTIO (3-0)3
Molecular weight distribution in linear and nonlinear chains. Configuration and conformation of chain molecules. Thermodynamics of macromolecular solutions. Phase equilibria in polymer systems. Frictional properties of dissolved macromolecules. Survey of recent theories for characterization of macromolecules in dilute solutions with special emphasis on the related experimental methods.

CHEM 546 ATOMIC SPECTROMETRY (3-0)3
Fundamentals of atomic spectrometry and signal generation. Novel optical and instrumental designs. Atomic absorption spectrometry, flame, furnace, platinum loop, tungsten wire atomizers, vapour generation techniques, atom trapping systems. Inductively coupled plasma atomic emission spectrometry and mass spectrometry. Electrothermal vaporization techniques. Flow injection and other automated systems in atomic spectrometry.

CHEM 547 CHEMICAL SENSORS (3-0)3
Contemporary trends in analytical chemistry. Analytical figures of merit; selectivity, sensitivity and detection limits. Chemical sensors based on fiber optic spectrometry, electrochemistry and acoustic interactions.

CHEM 548 PHYSICAL CHEMISTRY OF INTERFACES (3-0)3
Viscous behaviour of dispersion, diffusion and sedimentation of colloidal particles, surface tension, contact angle and wetting, experimental methods, adsorption from solution, electrical properties of colloids, stability of dispersion, thin films, hydrodynamical effects and colloidal stability.

CHEM 549 TOTAL SYN.OF NAT.COMPOUNDS (3-0)3
Recent publications about the total synthesis of natural compounds, their backgrounds and biological activities. Synthetic strategies (retrosynthetic analysis), methods, reagents and experimental conditions in the synthesis of these compounds. Introduction of the logic of total synthesis and the rationale for the invention and the use of important synthetic methods used in organic chemistry.

CHEM 560 INORGANIC REACTION MECHANISMS (3-0)3
After a brief review of the present theories which account for metal-ligand bonding, the mechanisms of inorganic reactions in solution are studied under the following subtitles, 1) Ligand substitution reactions of square-planar, tetrahedral and octahedral transition metal complexes, 2) Electron transfer reaction, 3) Oxidative addition reactions. 4) Catalysis reactions.

CHEM 562 INORGANIC PHOTOCHEMISTRY (3-0)3
Introduction to excited states (ES), ES lifetimes and reactions. Techniques in continuous and flash photoloysis. Kinetic of photophysical processes. Charge transfer photochemistry. Substitutional Photochemistry of First Row and Heavier Transition Elements. Photochemistry of Carbonyl Complexes. Type of laser used in TRO and TRIR techniques.

CHEM 564 STRUCTURE &MORPHOLOGY OF MACROMOLECULE (3-0)3
Molecular structure of macromolecules. Types of macromolecules with respect to crystal structure. Crystallization of polymeric compounds. Morphology of polymers. Degree of crystallinity in polymers. Optical properties of polymeric materials. Macrostructure from small-angle x-ray scattering. Microstructure from wide-angle x-ray diffraction.

CHEM 565 FIBRE SCIENCE AND TECHNOLOGY (3-0)3
Properties of Polymers used for fiber formation, Properties and classification of fibers, methods of spinning fibres and characterization, Melt spinning technologies are discussed.

CHEM 568 BIOMEDICAL MATERIALS (3-0)3
Classification, and characterization of materials which are used in biomedical area. Metals, metal alloys, ceramics, polymers and their structure-property relationships. Tissue and blood response to implants and their tests.

CHEM 571 BLOCK AND GRAFT COPOLYMERS (3-0)3
Preparation of block copolymers by living anionic polymerization, free radical polymerization, cationic polymerization, stepgrowth polymerization and other techniques. Characterization of block copolymers. Mechanical and thermal properties. Synthesis and properties of graft copolymers.

CHEM 574 INORGANIC POLYMERS (3-0)3
Definition and special characteristics of inorganic polymers. Preparation and structure of two, three, three-four and greater than four network polymers. Polyphosphates, ultraphosphates, borophosphate, boron nitride, polymeric sulfur nitride, silicate glasses, borosilicate glasses, glass ceramics. Applications of inorganic polymers in technology.

CHEM 589 EXP. TECHN. IN ATMOSPHERIC CHEMISTRY (3-0)3
Sampling and analysis techniques used in atmospheric research. Overview of natural and polluted environments, experimental kinetics, mechanics and spectroscopic techniques, monitoring techniques for gaseous criteria pollutants, environmental chambers, sampling and collection of gaseous pollutants and atmospheric particulate matter, determination of sizes of particles, determination of chemical composition.
Prerequisite: Consent of the department.

CHEM 591 ADVANCED TOPICS IN ORGANIC CHEMISTRY (3-0)3
Basic and some advanced topics of organic chemistry, reaction mechanisms and molecular orbital theory.

CHEM 592 ADVANCED CHEM. PERSECTIVES IN BIOCHEM. (3-0)3
Review of selected Biochemistry topics at an advance level with a chemical perspective. Physical interactions that determine the properties of proteins, conformational properties of polypeptide chains, proteins in solution and in membranes. An advanced treatise on the photosynthesis and electron transport chain.

CHEM 593 ADVANCED TOPICS IN ANALYTICAL CHEMISTRY (3-0)3
This is one of the three courses should be taken by first year graduate students working in the area of Analytical Chemistry. Chemical Equilibrium, Statistical methods in Analytical Chemistry, Advance instrumentation one the main subject.

CHEM 595 ADVANCED TOPICS IN INORGANIC CHEMISTRY (3-0)3
Review of undergraduate inorganic topics at advanced level. After a short summary of atomic and molecular structure , MO orbitals of polyatomic molecular, MO theory and band theory of solids, bonding and electronic structure of coordination compounds and structures and synthesis of organometallic compounds will be discussion.

CHEM 597 ADVANCED TOPICS IN PHYSICAL CHEMISTRY (3-0)3
Basic principles of statistical thermodynamics, quantum chemistry, photochemistry and some other advanced topics of physical chemistry.

CHEM 599 FRONTIER MOLECULAR THEORY OF ORGA. CHE (3-0)3
a) M.O. Theory and frontier molecular orbitals,b) Frontier molecular orbitals and the chemical reactivity, c) HSAB principle, d) Primary and secondary orbital interactions, e) Regioselectivity, periselectivity, stereoselectivity and FMO theory, f) Applications.

CHEM 600 PH.D. THESIS NC
Program of research leading to Ph.D. degree, arranged between student and a faculty member. Students register to this course in all semesters starting from the beginning of their third semester while the research program or write-up of thesis is in progress.

CHEM 601 SEMINAR IN CHEMISTRY III (0-2)NC
This seminar consists of meetings among the department staff, invited guests and graduate students to discuss recent developments in Chemistry.

CHEM 602 SEMINAR IN CHEMISTRY IV (0-2)NC
A continuation of 2340601.

CHEM 7XX SPECIAL TOPICS IN CHEMISTRY (3-0)3
Courses not listed in catalogue. Contents vary from year to year according to interest of students and instructor in charge. Typical contents include contemporary developments in Analytical, Inorganic, Organic and Physical Chemistry.

CHEM 8XX SPECIAL STUDIES (4-2)NC
M.S. students choose and study a topic under the guidance of a faculty member normally his/her advisor.

CHEM 9XX ADVANCED STUDIES (4-0)NC
Graduate students as a group or a Ph.D. student choose and study advanced topics under the guidance of a faculty member, normally his/her supervisor.